

Fisheries survey of Himachal Pradesh and some adjacent areas with special reference to trout, mahseer and allied species¹

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INTRODUCTION

Our knowledge of the fish and fisheries of Himachal Pradesh is very meagre. Menon (1954) listed some of the species of fish while describing 'Fish Geography of Himalayas'. The hill areas of Himachal Pradesh range in elevation from 353 to 6470 metres above sea level. Innumerable streams with clear water traverse the various parts of the State and hold trout, mahseer and other species. The climatic conditions in the State vary from temperate to arctic. Due to varied climatic conditions, the survey was done according to the approachability of a particular part of the State. The survey was undertaken from February to June 1965 and in November 1965. The aims and objective of the survey were (a) to gather data on the position of trout and mahseer fisheries in the hill streams (b) to collect data on hydrobiological conditions of the streams containing trout, mahseer and other species (c) to make inventory of fish species present in the various drainages and to determine their distribution and relative abundance and (d) to assess the total fishing potential by gathering data on fishing methods and gears.

MATERIAL AND METHODS

For survey, important sampling stations on the basis of the number of fishing licences issued for each stream in each district were marked and collections made. Since there are no fish landing or assembly centres in the State, catch composition from each stream was determined by 50 castings done with a cast net of 0.6 cm mesh. The diameter of the net

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when extended by casting was 2.5 m. Small fish and insect life inhabiting the shallow areas of the streams below stones were collected by enclosing one square metre of the substratum with fine square mesh netting cloth and sweeping this area completely. Small fish and insects were collected in the cloth and then picked up. Water samples were analysed according to standard methods of water analysis.

PHYSIOGRAPHICAL FEATURES OF THE DRAINAGE

Himachal Pradesh, in north-west Himalayas, is a hill territory of 28,241 square kilometres and is bounded on the south by Uttar Pradesh and Punjab; on the north-west by Jammu and Kashmir and on the north-east by Tibet. The State is divided into six districts (Chamba, Mandi, Bilaspur, Mahasu, Kinnaur and Sirmur) for administrative purposes.

The five major rivers which drain the water sheds of the Pradesh are Chenab, Ravi, Beas, Sutlej and Yamuna. Since the Chenab flows only through a short length of Chamba and the area is not accessible it was not included in the survey programme. The region between the water shed of Dhouladhar bordering Kangra Valley and that of Pirpanjal constitutes the Ravi basin. The Ravi is the principal drainage of Chamba district. In its westerly flow, the Ravi receives Sal and Suil streams on the right and Mehla, Chanet and Naini streams on the left banks. The Beas which drains part of Chamba district and the whole of Mandi district has its origin at Beas Kund in Kulu. While flowing in a south-westerly direction the river receives Tirthan, Bakhili, Juni, Suketi and Seon streams on the left and Uhl, Rana, Gogli, Bharal, Dehar and Chakki on the right bank. Each of these tributaries in turn receives several side streams forming independent water systems. The Sutlej after flowing through Tibet enters Himachal Pradesh at Shipkila and drains the entire water sheds of Kinnaur, Bilaspur and part of Mahasu district. The principal tributaries are Baspa, Mangla, Gassi, Nogli, Behra, Ali, Ghambar and Ghambrola on the left and Wangad, Barari, Seer and Suker on the right banks. In addition, the Sutlej receives several seasonal streams in Bilaspur district draining the Siwalik hills. The Yamuna which drains the water sheds of Sirmur and partly of Mahasu districts has comparatively few tributaries within Himachal Pradesh. The major ones are River Paber which joins with River Tons near Tiunni in Uttar Pradesh, Tons, Giri, Bata, and Markanda all debouch from the right bank. A complete list of the streams surveyed along with places of sampling and approximate elevation is given in Appendix I while the five rivers and their principal tributaries are shown in Fig. 1.

PHYSICO-CHEMICAL CONDITIONS AND INSECT LIFE OF THE STREAMS

(a) *Physico-chemical conditions* :

The study of physico-chemical factors included air and water temperature, pH, dissolved oxygen, total alkalinity, chlorides, silicates, nitrates and phosphates. On the basis of the ecological conditions and physico-chemical factors, the streams have been divided into three categories as described in the following paragraphs and Table I.

(1) 'Trout streams' are snow fed and situated at an elevation of 1470 metres and above. The other conditions are fast and turbulent currents, forest flora of the surrounding hills mainly of *deodar*, *kail* and *sal* trees and a substratum of boulders and rocks either pitted or smooth.

(2) 'Snow trout streams' which receive partly snow water and partly spring water flow at elevations ranging from 875 to 1470 metres above sea level. Other features are moderate current forming rapids and pools alternately, hilly forest flora consist mainly of *sal*, pine and bushy plants. The substratum consists of sand, boulders and stones covered with slimy algal matter and moss.

(3) 'Mahseer streams' which receive spring or rain water are situated at an elevation below 875 metres above sea level. Other features of such streams are slow current forming deep pools at places which sometimes are choked with filamentous algae and submerged vegetation; forest flora on the surrounding hills consist of pine, *shisham* and thorny bushes; soil erosion is a great problem and streams carry great quantities of silt during rains. The substratum is composed of pitted rocks and small stones covered with slimy algal matter.

(b) *Insect fauna* :

Insect fauna in the mountain streams depend primarily on the velocity of the current and nature of the substratum (Hora 1936). In the streams where current is swift and the stones of the substratum are bare or covered with algal matter, insect life is largely nymphs of Ephemeroptera and Plecoptera and larvae of Trichoptera, Diptera and Coleoptera in percentages of 67.42, 7.20, 11.40, 7.20 and 6.78% by number respectively. Important forms of insects inhabiting such streams are *Baetis*, *Epeorus*, *Ephemerella*, *Heptagenia* and *Iron* among Ephemeroptera; Perlidae among Plecoptera; *Philopotamus* and *Rhyacophila* among Trichoptera; Blepharoceridae and Simuliidae among Diptera; and Haliplidae and Psephenidae among Coleoptera. Distribution of *Baetis* and *Epeorus* and Blepharoceridae is interesting. In Baspa and Paber streams, which show substrata consisting of bare stones and fast current, *Baetis*, *Epeorus* and Blepharoceridae are abundant. On the other hand Uhl river which has pitted rocks and a substratum stones covered with brown, slimy algal matter, the three forms were not abundant. Nymphs of Plecoptera

TABLE I
 RANGES OF PHYSICO-CHEMICAL FACTORS AND AVERAGE VALUES FOR CERTAIN TROUT,
 SNOW TROUT AND MAHSEER STREAMS IN HIMACHAL PRADESH

Type of stream	Number sampled	Air temp. °C	Water temp. °C	pH	Dissolved oxygen in ppm.	Total alkalinity in ppm.	Chlorides in ppm.	Silicates in ppm.
Trout stream	10	12.0-29.0 (20.4)	7.0-16.0 (10.9)	7.5-8.0 (7.7)	10.2-11.8 (11.0)	32.0-48.0 (38.2)	4.0-6.0 (4.6)	0.42-0.56 (0.51)
Snow trout stream	20	15.0-38.0 (24.5)	7.2-20.7 (15.0)	7.2-8.5 (8.0)	8.0-11.2 (9.6)	32.0-68.0 (46.5)	4.0-8.0 (6.6)	0.44-0.59 (0.53)
Mahseer stream	11	20.0-33.0 (25.4)	18.5-25.0 (21.0)	8.3-8.8 (8.6)	7.8-8.4 (8.1)	64.0-88.0 (78.0)	6.0-8.0 (7.1)	0.50-0.61 (0.55)

were abundant in Suil and Andhra streams which have strong current and a substratum of bare stones with algal encrustation.

Insect life of the streams which have moderate current forming pools and rapids alternately consist mainly of the nymphs of Ephemeroptera, Odonata and Plecoptera and larvae of Trichoptera, Diptera and Coleoptera in percentages of 38·83, 6·34, 3·53, 28·20, 9·40 and 13·70% respectively by number. In these streams nymphs of Ephemeroptera are represented mainly by *Ephemerella* and *Epeorus*; Odonata by Gomphidae and Agrionidae; Plecoptera by Perlidae and Chloroperlidae; Trichoptera by Leptoceridae and *Rhyacophila*; Diptera by Blepharoceridae, Tipulidae and Simuliidae and Coleoptera by adults and larvae of Dytiscidae and Psephenidae. Nymphs of Odonata have been recorded in maximum number in Suketi, Ali and Ashmi streams. These streams were choked with mats of *Spirogyra* and other aquatic plants like *Hydrilla* and *Potamogeton*.

A complete list of insects and other aquatic animals recorded from the various hill streams is given in appendix II.

FISHING METHODS

The common methods of fishing prevalent in Himachal Pradesh are simple but well-suited to the mountain streams. Fishing methods can broadly be divided into two sub-heads namely (a) nets and (b) other methods.

(a) Nets

The principal types of nets used for fishing in the hill streams are cast net, drag net, gill net and stake net. Since the shape and operation of these nets differ considerably from the conventional types used in the plains, they are briefly described below.

Cast Net

It is a universal gear used for catching small and medium-sized fish. It is known by different names depending on the size of the mesh used. The different names given to this net are 'sorrū' (1·2 cm mesh), 'werū' (1·8 cm mesh), 'dobajū' (2·5 cm mesh) and 'palka' (3 cm mesh). The diameter of the net when extended by casting varies from 1 to 2 metres. A major feature of the net is that solid iron sinkers weighing about 5 kg are fixed to the net on the peripheral cord. On account of heavy sinkers the net settles down immediately at the bottom thus preventing the fish from escaping. As the net after casting settles at the bottom, the fisherman with his feet disturbs the stones which helps in bringing the fish to the pockets of the net. It is generally used for catching *Labeo dero*,

Oreinus plagiostomus, *Garra gotyla*, *Barilius* spp. and yearlings of *Tor putitora*.

Drag net

Drag net or 'Bigha' or 'Kadh' etc. as it is called locally is generally used to fish in pools of the rivers and their principal tributaries in the lower reaches having moderate current. Its use is limited to dry season when water level in the streams is low. In the rivers it is often employed in shallow pools and places where the river breaks up into several channels. Drag net is always employed in conjunction with stake net. A stake net is fixed across the shallow tail end of the pool. The minimum of 3.0 cm mesh is the common type used in Mandi, and Sirmur. The net is gradually brought downstream from the head end of the pool by a line of men swimming and diving to drive the fish. Heavy sinkers are attached to the lower end of the net so that while being dragged downstream the net remains close to the bottom preventing fish from escaping. As the drag net is brought downstream and approaches the stake net, large number of fishermen with cast net fish the area between the two nets. This method is employed for commercial fishing of *Tor putitora*, *Labeo dero* and *L. dyocheilus*.

Gill net

It is known as 'Nilotu' or 'Pand'. The minimum permissible mesh is 4.5 cm. It is a kind of gill-cum-wall net fixed across the stream near the head end of the pool having slow current. The net is usually fixed at night with the bottom resting on the bed of the pool. To keep the net in an upright position, small stones and dry grass (Kana) are used as sinkers and floats respectively. The two ends of the net are tied to a tree or boulder on either banks of the stream. During movements the fish gets gilled.

Nylon gill nets are operated in Gobindsagar Lake near Bilaspur by the State Fisheries Department.

Stake net

It is known as 'Bar Patta' locally. Its operation is limited to certain areas of the main rivers. These nets are operated from August to November. The net with minimum mesh of 3.7 cm is fixed across a stream with stones and perpendicular bamboo stakes. The net near the two banks is kept low in height. Fish which descend down to the river after spawning find their way obstructed and try to escape through the sides near the banks. While doing so, they are caught by number of fishermen with cast nets. This is one of the specific methods used for catching mahseer in descending phase of spawning migration.

(b) Other Methods

Under this sub-head are included rod and line with artificial lures for trout fishing ; long lines with spoon for mahseer fishing ; spear fishing for mahseer and other species. In addition, indiscriminate destruction of young and big fish is done by adopting illegal methods like dynamiting, diversion of water for killing of young fish and poisoning with certain indigenous plants.

FISH FAUNA

During the survey, forty-four species of fish belonging to various orders and families have been collected. Of these four species have been recorded for the first time in Himachal Pradesh. These are *Raimas bola* (Hamilton), *Tor mosal* (Hamilton), *Puntius chagunio* (Hamilton) and *Glyptosternum reticulatum* (McClelland). Table II gives a list of the species, distribution in the State and their general distribution. Certain species have been recorded to prefer particular ecological conditions and are described below.

Barilius bendelisis chedra (Hamilton)

This species was taken from streams with moderate current having substrata of stones covered with slimy algal matter. Temperature tolerance is wide, ranging from 18.5°C to 35.0°C. This species has not been recorded from upper Mahasu and Kinnaur districts where purely snow fed streams occur. Large number of fry have been collected during February-March and June-July. Fertilised eggs have been collected in June from certain streams beneath the pebbles in shallow, slow running areas. The eggs are characterised by the orange colour of the yolk. Its maximum limit of distribution in the State is up to 1180 metres above sea level.

Raimas bola (Hamilton)

R. bola has been collected from a pool in Markanda river at Kala Amb in Sirmur district. This river is seasonal and retains water during the whole year only in some of its deep pools. The pools are covered with filamentous algae and aquatic vegetation. The species was associated with the fry and fingerlings of *B. bendelisis chedra* and *B. barna*.

Tor putitora (Hamilton)

T. putitora or the mahseer inhabits the major rivers of the State and their tributaries situated below 1180 metres m.s.l. excepting River Ravi in Chamba district, though this stretch of the river lies well below the

optimum elevation mentioned. This species appears to prefer streams maintaining temperature from 19.5°C to 25.5°C. The water temperature of Ravi system in Chamba district during May-June was 12.5°C to 18.5°C. Fry and fingerlings in thousands have been collected from shallow pools and below big boulders near the shore which are constantly flushed by the main current of the stream throughout the period of the survey. Large-sized fish prefer deep pools of the main rivers and their principal tributaries. In majority of the streams it is associated with *Labeo dero* and *L. dyocheilus* along with several unimportant species.

TABLE II
LIST OF FISHES RECORDED FROM HIMACHAL PRADESH

Sl. No.	Species	Distribution in H.P.	Remarks
Order CYPRINIFORMES			
Division Cyprini			
Sub-Order Cyprinoidei			
Family CYPRINIDAE			
Sub-family Rasborinae			
1.	<i>Barilius barila</i> (Hamilton)	Bilaspur	Throughout N. India, Bengal, Orissa and Lower Assam.
2.	<i>Barilius barna</i> (Hamilton)	Sirmur	Orissa, Bengal and Assam.
3.	<i>Barilius bendelisis chedra</i> (Hamilton)	Chamba, Mandi, Bilaspur, Lower Mahasu and Sirmur	Throughout India as far as W. Ghats and Ceylon.
4.	<i>Raimas bola</i> (Hamilton)	Sirmur	Orissa, Bengal and Assam.
5.	<i>Barilius shacra</i> (Hamilton)	Sirmur	North India and Assam.
6.	<i>Barilius vagra</i> (Hamilton)	Chamba, Mandi and Bilaspur	Rivers of Himalayan and sub-Himalayan ranges of N. India and Assam.
Sub-family Cyprininae			
7.	<i>Tor mosal</i> (Hamilton)	Lower Mahasu and Sirmur	Mountain streams of N. India.
8.	<i>Tor putitora</i> (Hamilton)	Mandi, Bilaspur, Lower Mahasu and Sirmur	Mountain streams of N. India.
9.	<i>Puntius chagunio</i> (Hamilton)	Sirmur	Orissa, Bengal, Assam and N.W. India.
10.	<i>Puntius conchonius</i> (Hamilton)	Chamba, Mandi, Bilaspur and Sirmur	From Punjab to Bengal, Southern India, Orissa and Assam.
11.	<i>Puntius ticto</i> (Hamilton)	Sirmur	India, Burma, Ceylon and Siam.
12.	<i>Labeo boga</i> (Hamilton)	Sirmur	Rivers of Gangetic delta, Madras and Burma.

TABLE II (contd.)

Sl. No.	Species	Distribution in H.P.	Remarks
13.	<i>Labeo dero</i> (Hamilton)	Chamba, Mandi, Bilaspur and Sirmur	Mountain streams of N. India and Assam.
14.	<i>Labeo dyocheilus</i> (McClelland)	Bilaspur	Hills of Punjab and Assam.
15.	<i>Cyprinus carpio</i> var. <i>specularis</i>	Chamba and Bilaspur	Exotic. Transplanted in Indian waters.
16.	<i>Cyprinus carpio</i> var. <i>communis</i>	Chamba and Bilaspur	Exotic. Transplanted in Indian waters.
17.	<i>Garra gotyla</i> (Gray)	Chamba, Mandi, Bilaspur, Mahasu and Sirmur	Mountain streams of W. Himalayas.
Sub-family Schizothoracinae			
18.	<i>Oreinus plagiostomus</i> (Heckel)	Chamba, Mandi, Bilaspur, Mahasu, Kinnaur and Sirmur	Kashmir, Punjab, Assam and Eastern Himalayas.
19.	<i>Oreinus sinuatus</i> (Heckel)	Chamba, Mandi, Bilaspur and Sirmur	Kashmir and Punjab.
20.	<i>Crossocheilus latius punjabensis</i> (Hamilton)	Chamba, Mandi, Bilaspur and Sirmur	Hill streams of Punjab and Kashmir.
Family COBITIDAE			
21.	<i>Nemachilus botia</i> (Hamilton)	Mandi	Throughout India (Except Malabar and Ceylon).
22.	<i>Nemachilus botia aureus</i> (Hamilton)	Mandi, Bilaspur and Sirmur	Throughout India (Except Malabar and Ceylon).
23.	<i>Nemachilus corica</i> (Hamilton)	Chamba, Mandi and Mahasu	Bengal, Punjab and Assam.
24.	<i>Nemachilus kangrae</i> Menon	Mandi and Bilaspur	Kangra Valley.
25.	<i>Nemachilus montanus</i> (McClelland)	Chamba	All along Himalayas.
26.	<i>Nemachilus rupicola</i> (McClelland)	Sirmur	All along Himalayas.
27.	<i>Nemachilus</i> sp.	Bilaspur	—
28.	<i>Nemachilus</i> sp.	Mahasu	—
29.	<i>Nemachilus</i> sp.	Mahasu	—
Sub-family Botinae			
30.	<i>Botia birdi</i> Chaudhuri	Bilaspur	Punjab, Himalayas, Gangetic valley and Assam.
Sub-family Cobitinae			
31.	<i>Lepidocephalus guntea</i> (Hamilton)	Chamba	Punjab, Bengal and Assam.
Division Siluri			
Sub-order Siluroidei			
Family SILURIDAE			
32.	<i>Wallago attu</i> (Bloch and Schneider)	Sirmur	India, Burma and Ceylon.

TABLE II (contd.)

Sl. No.	Species	Distribution in H. P.	Remarks
Family AMBLYCIPITIDAE			
33.	<i>Amblyceps mangois</i> (Blyth)	Mandi	Satpura-Vindhya ranges along the base of the Himalayas as far as Kangra Valley, Burma and Malaya.
Family BAGRIDAE			
34.	<i>Mystus (Osteobagrus) aor</i> (Hamilton)	Bilaspur	Punjab, Delhi, U.P., Bengal and Burma.
35.	<i>Mystus (Osteobagrus) seenghala</i> (Sykes)	Bilaspur	Punjab, Delhi, U.P., Bengal and Burma.
Family SISORIDAE			
36.	<i>Bagarius bagarius</i> (Hamilton)	Sirmur	Large rivers of India and Burma.
37.	<i>Glyptosternum reticulatum</i> (McClelland)	Chamba	Head waters of Indus, Kabul rivers, eastern Tibet and Sikkim.
38.	<i>Glyptothorax conirostres</i> (Steind)	Chamba, Mandi, Bilaspur and Mahasu	Himalayas from Kangra to Simla.
39.	<i>Glyptothorax pectinopterus</i> (Hamilton)	Chamba, Bilaspur and Mahasu	Punjab and U.P.
40.	<i>Glyptothorax stoliczkae</i> (Steind)	Chamba and Mahasu	Simla and Western Himalayas.
Order OPHICEPHALIFORMES			
Family CHANNIDAE			
41.	<i>Channa gachua</i> (Hamilton)	Mandi	India, Burma, Ceylon and the Andaman.
42.	<i>Channa marulius</i> (Hamilton)	Sirmur	Throughout India and Ceylon.
Order MASTOCEMBELIFORMES			
Family MASTOCEMBELIDAE			
43.	<i>Mastocembelus armatus</i> (Lacépédé)	Bilaspur	India, Burma and further east.
Order SALMONIFORMES			
Family SALMONIDAE			
44.	<i>Salmo trutta fario</i> Linnaeus	Mandi, Mahasu and Kinnaur	Exotic. Transplanted in the cold waters of Punjab, Himachal Pradesh and Kashmir.

Oreinus plagiostomus (Heckel)

This is the only indigenous species which thrives in the ice cold waters of trout streams at high altitudes. They have been collected with some exceptions from areas having elevation ranging from 1180 to 3000 metres m.s.l. The species has been collected in River Ravi during May at

Bhasoli and Thein, the places situated at an elevation of 500 metres m.s.l. The temperature tolerance of *O. plagiostomus* ranged from 8·0°C to 22·0°C. The occurrence of this species at Bhasoli and Thein may be on account of low water temperature (12·5°C-18·5°C). Fertilised eggs are of yellow to orange colour and have been collected at different periods in the various river systems. In Sutlej and Beas systems in Mandi and Bilaspur regions fertilised eggs have been collected in March. On the other hand in Sutlej system in Mahasu and Kinnaur districts and Ravi system in Chamba district, fertilised eggs have been collected from May to June. In general, the spawning grounds of *O. plagiostomus* have been located not in the main rivers but in the tributaries with temperature between 18·5°C and 21·5°C.

FISHERIES

Commercial catches of fish in Himachal Pradesh are entirely lacking on account of three main factors. Firstly, the hill streams are shallow and do not hold enough water excepting in some of the deeper pools during the year so as to facilitate the holding of large-sized fish. In the main rivers, conditions are somewhat better but due to strong current and very deep pools, fishing gears are not effective. Secondly, the permanent inhabitants of the hill streams are species which do not grow to large size and it is they which constitute the bulk of the catches. The average catch does not exceed 2 kg per net provided the fisherman work for at least 4 hours. Thirdly, due to difficult hilly terrain and lack of communication it is impossible for the professional fishermen to assemble their catches at a fixed place for disposal. They sell their catches individually. In the whole of Himachal Pradesh there are no fish assembly or marketing centres. Four types of fishery have been recognised in the State as described below.

(a) Trout Fishery

Trout fishery in the streams is constituted only by brown trout, *Salmo trutta fario* Linnaeus though rainbow trout, *Salmo gairdneri* Richardson has recently been introduced at Barot Trout Hatchery. There are two trout farms in the State at Barot and Chirgaon in addition to a few hatching troughs at Sangla. Regular stocking of the streams is done every year with the fry and fingerlings grown in the two farms. Introduction of brown trout in Himachal Pradesh dates back to 1916 when eyed-ova from Kulu were transplanted in Uhl valley. Independently, eyed-ova from Kulu were transplanted to a small hatchery near Chamba at Siran Ghat in 1910. From Uhl valley, trout was further transplanted in Paber and Baspa streams. Since then trout has established itself very well excepting in Chamba. The trout fishery in Chamba perished after the

devastating floods of 1947 in the Ravi. The old revenue records of the former princely State of Chamba reveal a flourishing trout fishery in Ravi till 1947 and fish up to 3 kg had been recorded. At present fish up to 3 kg in some of the best trout streams of the State is rare. The normal weight does not exceed 1.5 kg as revealed by anglers records. Efforts are being made by the State Fisheries Department to explore new areas of the State for development of trout fishery to attract more tourists.

(b) Snow trout Fishery

Snow trout fishery covers the species *Oreinus plagiostomus* and *O. sinuatus*. The two species account for the major catches in Chamba, Mahasu, Kinnaur and parts of Mandi and Bilaspur districts. Good quantity of the two species is caught in the Ravi from Chamba to downstream as far as Bhasoli (Jammu Province); in the Sutlej and its main tributaries from Kalpa to the tail end of Gobind-sagar reservoir; in the Beas and its principal tributaries between Aut and Mandi town and in the Yamuna and its tributaries including Paber, Tons, and Amlawa (U.P.). *O. plagiostomus* measuring 47 cm in length and weighing 1.4 kg has been taken by cast net at Seema in Paber river.

(c) Mahseer Fishery

Tor putitora is the only species giving commercial catches in the State. It forms a good fishery in the main rivers and their tributaries at lower elevations. In Ravi, as mentioned earlier, no trace of existence of mahseer fishery upstream of Madhopur Head Works has been recorded. It may probably be on account of two factors, firstly the water temperature above the barrage is low and secondly on account of barrage which may be an hindrance in the migration of this species. Good mahseer fishery below the barrage has been noted by Sehgal, Shukla and Shah (unpublished) in Gurdaspur district of Punjab. Important streams having mahseer in substantial quantity are the Beas from Aut to Sanghol and its principal tributaries Suketi, Seon, Bharal, Dehar and Chakki; the Sutlej (Gobind Sagar Lake) and its principal tributaries Gambhar, Gambhrola, Ali, Seer and Suker and the Yamuna between Kalsi (U.P.) and Paonta and its tributaries Giri, Bata and Markanda. Major mahseer fishing centres are Mandi, Sanghol, Ghumarwin, Bilaspur, Dadahu and Paonta.

Mahseer being a migratory fish ascends regularly from the main rivers to the tributaries for spawning in monsoon months and descends back before the onset of winter. Fish weighing upto 3 kg are generally caught in the pools of some of the major tributaries. Fish weighing more than 3 kg are caught in the rivers.

(d) Miscellaneous Fishery

Several small-sized species like *Labeo dero*, *L. dyocheilus*, *Garra gotyla*, *Barilius* spp. etc. constitute this category of hill fisheries. *L. dero* and *L. dyocheilus* rarely exceed 20 cm in total length and constitute the main catches in the tributaries.

CONCLUSIONS

1. Physico-chemical conditions of the mountain streams at higher elevations are characterised by low water temperature, pH close to neutral point, high value of dissolved oxygen and low value of silicates. Trout and *Oreinus plagiostomus* are the species thriving in such streams. Insect life is also specialised and best suited to the swift running waters. Algae and other aquatic vegetation are scanty. The mountain streams at lower elevations on the other hand have higher water temperature, alkaline pH, higher values of total alkalinity and silicates. Such streams contain different types of insects, fish and other aquatic animals.

Trout waters in Himachal Pradesh, at present, are confined only to a few areas in the State. Possibilities of exploitation of new areas in Himachal Pradesh are many. For instance in Chamba district alone Sal and Suil along with their main side streams are some of the streams which afford suitable conditions for transplantation of trout. The analysis of physico-chemical factors and insect life has shown that the conditions are more or less similar to the typical trout streams of the State. These streams are very rich in *Oreinus plagiostomus* of all sizes.

3. Mahseer fishery needs an immediate protection. Destructive methods of fishing like dynamiting, poisoning and diversion of water for catching fish are some of the important factors responsible for decline in mahseer fishery. Even the sanctuaries have not been spared from these destructive methods. In the tributaries, juveniles need full protection, when water level goes low in summer months. To protect them from poaching, certain artificial pools need to be created. Fishing should be prohibited during spawning migration. Some of the deepest pools in the principal tributaries need to be declared as protected and reserved waters. Mass killing of mahseer during migratory phase has adverse impact on the mahseer fishery of the Beas and the Sutlej at Amritsar, Ferozepore, Harike, Ludhiana and Jullunder. The mahseer fishery as per Punjab Fisheries data, in these areas, have declined from 3.57% in the total catch during 1961 to 0.67% in 1965. As mahseer affords an excellent sport even better than trout, adequate conservation measures are necessary.

Cultural possibilities of common carp in the hills of Himachal Pradesh needs further exploration particularly in impounded waters.

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